REMARKS

This Preliminary Amendment includes a Substitute Specification in which a literal translation of the original German patent application is revised in accordance with English idiom and U.S. patent practice. Care was exercised to avoid the introduction of new matter. An English-language abstract is also submitted.

Claims 1-6 are amended to recite the subject matter in customary U.S. format and to eliminate multiple dependencies. No new matter is introduced.

Favorable consideration of this application is respectfully requested. If any unresolved issues remain, it is respectfully requested that the Examiner telephone the undersigned attorney at (703) 425-8508 so that such issues may be resolved as expeditiously as possible.

Respectfully Submitted,

DITTHAVONG & CARLSON, P.C.

12/27/05
Date

Reg. No. 44,658

Margo Livesay, Ph.D.
Attorney/Agent for Applicant(s)
Reg. No. 41,946

10507 Braddock Road
Suite A
Fairfax, VA 22032
Tel. (703) 425-8508
Fax. (703) 425-8518

~~Translation of PCT/EP2004/006618~~

Attenuator System

FIELD OF THE INVENTION

The invention relates to an attenuator system for adjusting the output power of a high-frequency signal source.

BACKGROUND OF THE INVENTION

Attenuators for adjusting the output power of high-frequency signal sources such as signal generators are known in extremely diverse embodiments. The throughput attenuation of an attenuator of this kind can be adjusted within a broad dynamic range through a stepwise connection and disconnection of attenuation elements. The individual attenuation elements are connected to T networks or Pi networks by changeover switches, which are ~~realised~~ realized as electronic switches in modern equipment. Attenuators of this kind, which can be switched by means of electronic switches such as PIN diodes or transistors, for example, gallium arsenide MESFET transistors, are referred to as electronic attenuators.

~~An electronic attenuator of this kind is known, for example, from~~Published German patent application DE 100 63 999, for example, discloses such an electronic attenuator.

The advantage of such electronic attenuators is in the faster switching speed and a substantially lower dependence of the operating life upon the number of

switching cycles by comparison with attenuators with mechanical switching relays. One disadvantage of electronic attenuators, however, is their relatively high insertion loss (minimum attenuation, fundamental attenuation), for example, up to 5 dB, and their reduced linearity. Furthermore, the maximum output power is lower than with mechanical attenuators with mechanical changeover switches.

SUMMARY OF THE INVENTION

~~The object of the invention is~~There exists a need to provide an attenuator, which combines the advantageous properties of an electronic attenuator with a low insertion loss.

~~This object is achieved on the basis of~~In accordance with one aspect of the present invention, an attenuator system for adjusting the output power of a high-frequency signal source ~~according to the invention by the characterising features of the independent claim. Advantageous further developments are specified in the dependent claims~~is disclosed herein.

By means of the bypass line (bypass), which, according to an aspect of the invention, is connected mechanically parallel to a conventional electronic attenuator, which comprises ~~essentially only~~ two simple, coaxial changeover switches or transfer switches with a coaxial line component connecting the latter, the electronic attenuator can be used in the conventional manner for a low output power of the signal source; for a higher output power, the mechanical bypass is connected and the electronic attenuator is disconnected, so that the full

output power of the HF signal source is connected through to the output via the practically attenuation-free bypass.

In this bypass switching position, the output line can be adjusted through the output amplifier of the signal source, or the bypass itself can be formed as a mechanical attenuator; ~~that is to say~~ i.e., with additional mechanical coaxial changeover switches in the bypass, it is possible to switch between two or more different attenuation elements, so that the output power can also be adjusted for higher powers.

According to ~~one further development~~an aspect of the invention, the two, for example, bi-stable coaxial changeover switches at the input and output of the electronic attenuator, which are provided for the connection of the bypass, can, at the same time, also be exploited for the purpose of over-voltage protection. Accordingly, it is ~~only necessary~~possible to assign to the output of the signal source a corresponding over-voltage detector which, for example, in the event of a connection of a high external voltage to the output of the signal source, disconnects the electronic attenuator from the output via the output-end mechanical changeover switch, so that the electronic attenuator is then connected via the other mechanical changeover switch only to the signal source. Accordingly, irreversible changes and/or damage to the electronic attenuator, the signal source and other circuit components resulting from over-voltage at the device output are prevented.

The lines and mechanical switches used in the system according to an embodiment of the invention ~~must, of~~

~~course,~~may be high-frequency compatible and are therefore designed, for example, as coaxial lines, coaxial changeover switches, multiple changeover switches or transfer switches with a defined surge impedance.

Still other aspects, features, and advantages of the present invention are readily apparent from the following detailed description, simply by illustrating a number of particular embodiments and implementations, including the best mode contemplated for carrying out the present invention. The present invention is also capable of other and different embodiments, and its several details can be modified in various obvious respects, all without departing from the spirit and scope of the present invention. Accordingly, the drawing and description are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in greater detail below with reference to a schematic drawing of an exemplary embodiment. The drawing is as follows:

Figure 1 shows an exemplary embodiment of an attenuator system ~~according to~~consistent with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows an attenuator system 10 according to an embodiment of the invention for adjusting the output power of a high-frequency signal source 1, for example, a signal generator, at the output 2. For this purpose, a

conventional electronic attenuator 5, of which the attenuation elements are connected and disconnected via semiconductor elements, such as metallic semiconductor field effect transistors (MESFET), is connected between the signal source 1 and the output 2, via an input-end mechanical changeover switch and an output-end mechanical changeover switch 3, 4.

The attenuation of this electronic attenuator 5 is variable, for example, within the range between nominal 0 dB (on the basis of the fundamental attenuation or insertion loss up to 5 dB real) and 125 dB in 5 dB steps within the frequency range between 100 kHZ and 3 GHz. A coaxial bypass line 6 is arranged parallel to this electronic attenuator 5 between the two mechanical changeover switches 3 and 4. The two changeover switches 3 and 4 are designed, for example, as mechanical relay switches (SPOT = Single Pole Double Through Relays) and can be switched jointly by means of a switchgear 7.

This switchgear 7 is connected to the setting mechanism 8 for the output power of the signal source 1 in such a manner that, for a low output power below a predetermined power threshold, the two relay changeover switches 3 and 4 occupy the switching position I, and accordingly connect the electronic attenuator 5 between the signal source 1 and the output 2. If a higher output power is set by the setting mechanism 8 of the signal source 1, the two mechanical changeover switches 3, 4 are switched by the switchgear 7 into the switching position II, and the signal source 1 is therefore connected via the coaxial bypass line 6 directly to the output 2. Accordingly, the maximum output power is then available at the output 2 and is no longer attenuated by the

fundamental attenuation (insertion loss) of the electronic attenuator.

If a further fine adjustment of the output power is ~~required~~ desired in this higher power range, it may be advantageous to form the coaxial bypass line 6 itself as a mechanical attenuator and to connect, for example, two or more attenuation elements into the bypass line 6 through additional mechanical changeover switches.

The switchgear 7 of the mechanical changeover switches 3, 4 can advantageously be connected to an over-voltage detector 9 assigned to the output 2 of the attenuator system 1 in such a manner that, if a permitted level is exceeded at the output 2, the output-end mechanical changeover switch 4, disconnects the electronic attenuator 5 from the output 2, and the input-end mechanical changeover switch 3 connects the electronic attenuator 5 to the signal source 1.

The attenuator system 10 according to an embodiment of the invention is not only advantageous for HF signal generators, but, with the provision of the bypass line 6, could also be used with other measuring devices such as network ~~analysers~~ analyzers or spectrum ~~analysers~~ analyzers or even with high-frequency receivers in the input stage, that is to say, anywhere, where the relatively high fundamental attenuation and/or poorer linearity of an electronic attenuator 5 is problematic.

While the present invention has been described in connection with a number of embodiments and implementations, the present invention is not so limited but covers various obvious modifications and equivalent

arrangements, which fall within the purview of the appended claims.

~~Claims~~ **What is claimed is:**

1. Attenuator system (10) for adjusting the output power of an HF signal source (1),
characterised in that
an electronic attenuator (5) with a mechanical changeover switch at the input-end and at the output-end (3, 4) is arranged between the signal source (1) and an output (2), and that these mechanical changeover switches can be switched in such a manner, that, in one switching position (I), the electronic attenuator (5) is connected between the signal source (1) and the output (2), and in the other switching position (II), a direct bypass line (6) is connected between the signal source (1) and the output (2).

2. Attenuator system according to claim 1,
characterised in that
the bypass line (6) is formed as a mechanical attenuator, which can be switched by means of mechanical switches between several attenuation values.

3. Attenuator system according to claim 1 or 2,
characterised in that
the mechanical changeover switches (3, 4) are bi-stable coaxial relay changeover switches.

4. Attenuator system according to claim 1 or 2,
characterised in that
the mechanical changeover switches (3, 4) are transfer switches.

5. Attenuator system according to any one of the preceding claims,
characterised in that
the switchgear for the mechanical changeover switches (3, 4) is connected to the output-power setting mechanism of the signal source (1) in such a manner that, above a predetermined output power, the bypass line (6) is connected between the signal source (1) and output (2), and below this predetermined output power, the electronic attenuator (5) is connected between the signal source (1) and output (2).

6. Attenuator system according to any one of the preceding claims,
characterised in that
the switchgear of the mechanical changeover switches (3, 4) is connected in such a manner to a over-voltage detector (9) assigned to the output (2) of the signal source (1), that, if a permitted level is exceeded at the output (2), the mechanical changeover switch (4) at the output-end disconnects the electronic attenuator (5) from the output (2), and the mechanical changeover switch (3) at the input-end connects the electronic attenuator (5) to the signal source (1).

ABSTRACT

An attenuator system for adjusting the output of an HF signal source is described in which, between the signal source and an output, an electronic attenuator is disposed via mechanical switches on the input and output side. The mechanical switches can be switched in such a manner that, in one switch position, the electronic attenuator is inserted between the signal source and the output, and in the other switch position, a direct by-pass is inserted between the signal source and the output.